

## 2012 MCAS Exam Test Items

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Test item alignment to

Energy 1: Integrating Sciences through Energy  
Questions 1, 7, 12, 14, 16, 32, 36, 37 & 45 directly align.

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## XIX. Chemistry, High School

## High School Chemistry Test

The spring 2012 high school Chemistry test was based on learning standards in the Chemistry content strand of the Massachusetts *Science and Technology/Engineering Curriculum Framework* (2006). These learning standards appear on pages 69–73 of the *Framework*.

The *Science and Technology/Engineering Curriculum Framework* is available on the Department website at [www.doe.mass.edu/frameworks/current.html](http://www.doe.mass.edu/frameworks/current.html).

Chemistry test results are reported under the following four MCAS reporting categories:

- Atomic Structure and Periodicity
- Bonding and Reactions
- Properties of Matter and Thermochemistry
- Solutions, Equilibrium, and Acid-Base Theory

### Test Sessions

The high school Chemistry test included two separate test sessions, which were administered on consecutive days. Each session included multiple-choice and open-response questions.

### Reference Materials and Tools

Each student taking the high school Chemistry test was provided with a Chemistry Formula and Constants Sheet/Periodic Table of the Elements. Copies of both sides of this formula sheet follow the final question in this chapter.

Each student also had sole access to a calculator with at least four functions and a square-root key.

The use of bilingual word-to-word dictionaries was allowed for current and former English language learner students only, during both Chemistry test sessions. No other reference tools or materials were allowed.

### Cross-Reference Information

The table at the conclusion of this chapter indicates each item's reporting category and the framework learning standard it assesses. The correct answers for multiple-choice questions are also displayed in the table.

# Chemistry

## SESSION 1

### DIRECTIONS

This session contains twenty-one multiple-choice questions and two open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

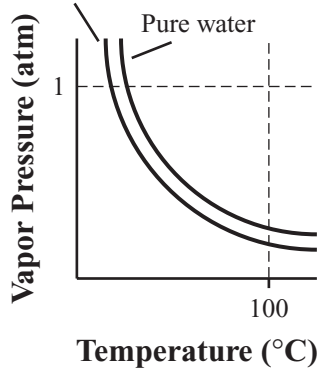
- 1 Which of the following statements describes the difference between endothermic and exothermic chemical reactions?
- A. Energy is absorbed in endothermic reactions but is released in exothermic reactions.
  - B. Energy is conserved in endothermic reactions but is not conserved in exothermic reactions.
  - C. Endothermic reactions involve changes in the nucleus of an atom, but exothermic reactions do not involve changes in the nucleus.
  - D. Endothermic reactions occur when electrons are shared between atoms, but exothermic reactions occur when electrons are transferred between atoms.

- 2 Cobalt has an atomic mass of 59 and an atomic number of 27. What does this information reveal about **most** cobalt atoms?
- A. They contain more neutrons than protons.
  - B. They naturally have a net negative charge.
  - C. They attract protons more strongly than electrons.
  - D. They form ions with a charge of +27 in compounds.

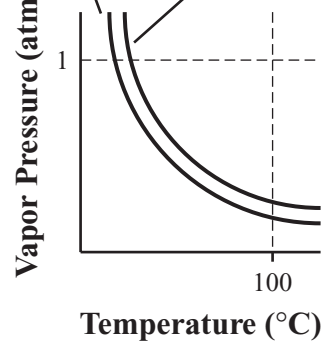
- 3 A liquid boils when its vapor pressure equals the pressure of the atmosphere. A student creates a graph of vapor pressure as a function of temperature for pure water and for a solution of water and sucrose.

Which of the following graphs **best** represents vapor pressure as a function of temperature for the two liquids?

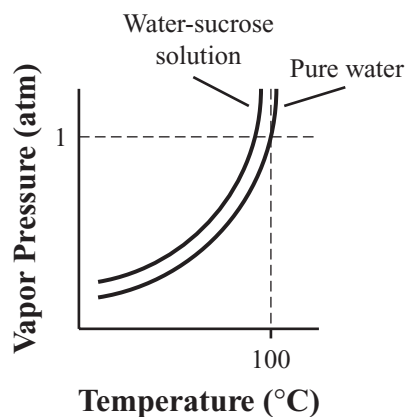
A. Water-sucrose solution



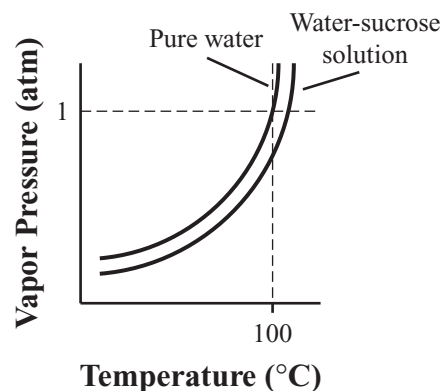
C. Pure water Water-sucrose solution



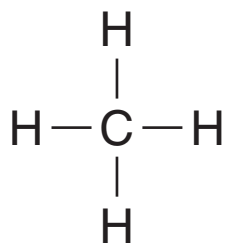
B.



D.



- 4 The diagram below represents one molecule of methane ( $\text{CH}_4$ ).



Which of the following is a balanced equation for the synthesis of methane from carbon and hydrogen?

- A.  $\text{C} + \text{H} \rightarrow \text{CH}_4$
- B.  $\text{C}_4 + \text{H} \rightarrow \text{CH}_4$
- C.  $\text{C} + 2\text{H}_2 \rightarrow \text{CH}_4$
- D.  $\text{C}_2 + 4\text{H} \rightarrow \text{CH}_4$

- 5 Which of the following subatomic particles can be found inside the nucleus of an atom?

- A. electrons only
- B. neutrons only
- C. protons and neutrons
- D. protons, neutrons, and electrons

- 6 The table below contains data for mercury and water at standard pressure.

Substance	Melting Point (°C)	Boiling Point (°C)
mercury	−39	357
water	0.0	100

Based on the data in the table, which of the following pairs of substances could exist at the same temperature?

- A. ice and liquid mercury
- B. liquid water and solid mercury
- C. water vapor and solid mercury
- D. liquid water and mercury vapor

- 7 Three identical balloons each contain one mole of gas. One balloon contains oxygen, one contains nitrogen, and one contains argon.

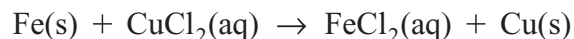
Which of the following changes in volume will happen if the balloons are placed in a warmer room?

- A. The balloon with argon will decrease most in volume because argon is a noble gas.
- B. All of the balloons will decrease in volume equally because the temperature increased.
- C. The balloon with oxygen will increase most in volume because oxygen has the largest molecules.
- D. All of the balloons will increase in volume equally because they have equal numbers of molecules.

- 8 How many electrons are in the outermost energy shell of a calcium atom?

- A. 1
- B. 2
- C. 6
- D. 8

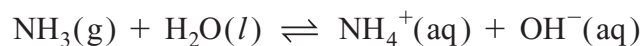
- 9 A student adds iron filings to a copper(II) chloride solution at room temperature. A balanced equation for the reaction that occurs is shown below.



Which of the following changes would **most likely** increase the reaction rate?

- A. using larger pieces of iron
- B. performing the reaction in an ice bath
- C. decreasing the volume of the  $\text{CuCl}_2$  solution
- D. increasing the concentration of the  $\text{CuCl}_2$  solution

- 10 The equation below shows the reaction of ammonia with water.



According to the Brønsted-Lowry theory of acids and bases, which of the following is acting as the acid for the forward reaction?

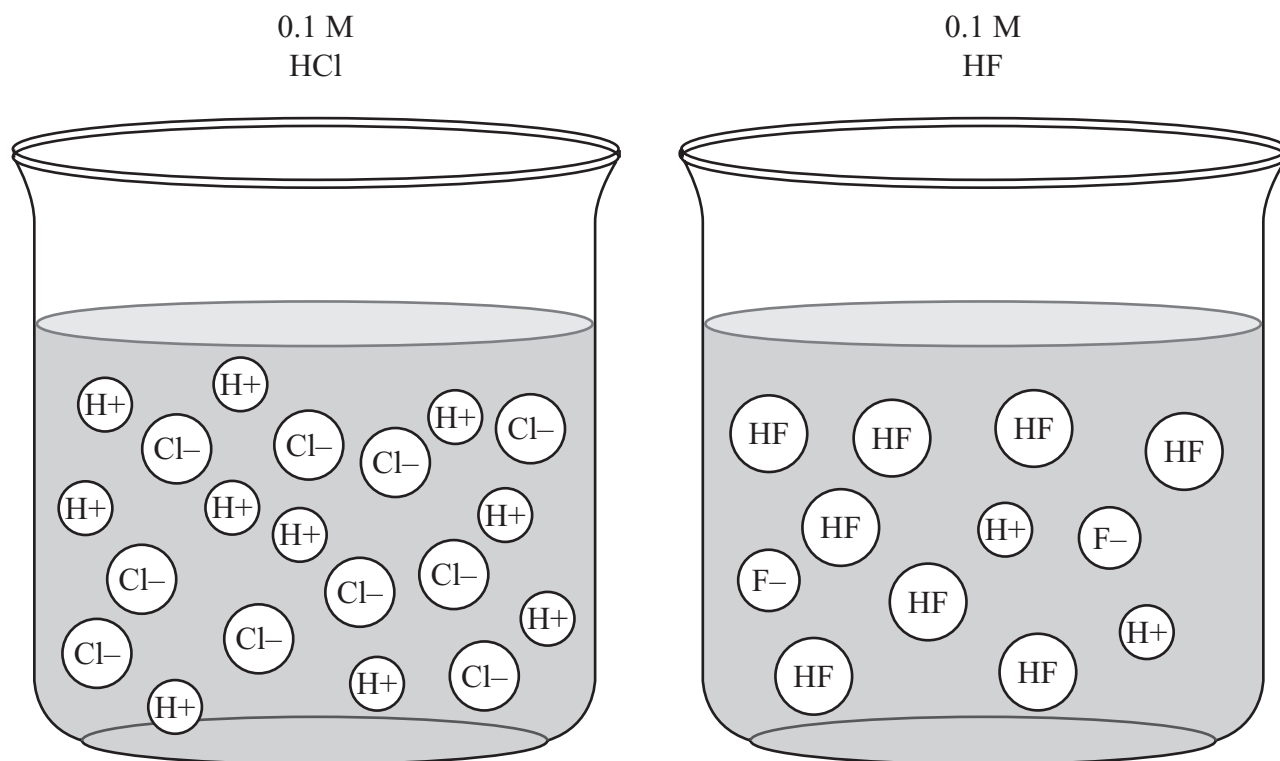
- A.  $\text{NH}_3$
- B.  $\text{H}_2\text{O}$
- C.  $\text{NH}_4^+$
- D.  $\text{OH}^-$

Question 11 is an open-response question.

- BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.
- Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.
- If you do the work in your head, explain in writing how you did the work.

Write your answer to question 11 in the space provided in your Student Answer Booklet.

- 11** The diagrams below show a 0.1 M aqueous solution of HCl and a 0.1 M aqueous solution of HF.



- Identify HCl and HF as acids or bases. Explain your answer.
- The pH of the 0.1 M HCl solution is expected to be lower than the pH of the 0.1 M HF solution. Explain why, based on the diagrams of the solutions and the definition of pH.



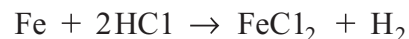
Mark your answers to multiple-choice questions 12 through 22 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

- 12 Which of the following statements **best** describes what happens to water during evaporation?
- A. The temperature of the water increases until the water molecules react with nitrogen in the air.
  - B. Water molecules on the surface overcome intermolecular forces and change into the gas phase.
  - C. Water molecules on the surface come in contact with air molecules and are pulled into the gas phase.
  - D. The temperature of the water increases until the water molecules separate and form oxygen and hydrogen gas.

- 13 Which of the following is a correct Lewis dot structure for potassium chloride?
- A.  $\text{K}^+[:\ddot{\text{Cl}}:]^-$
  - B.  $\text{K}^-[:\ddot{\text{Cl}}:]^+$
  - C.  $\text{K}^{2+}[:\ddot{\text{Cl}}:]^{2-}$
  - D.  $\text{K}^{2-}[:\ddot{\text{Cl}}:]^{2+}$

- 14 Which of the following statements best describes a difference between nuclear fission and nuclear fusion reactions?
- A. Nuclei split during fission and combine during fusion.
  - B. Fission forms heavier elements, and fusion forms lighter elements.
  - C. Fission generates potential energy, and fusion generates kinetic energy.
  - D. Nuclei gain electrons during fission and release electrons during fusion.

- 15 Iron(II) chloride ( $\text{FeCl}_2$ ) is a product of the reaction between iron metal (Fe) and hydrochloric acid (HCl), as shown in the equation below.



What is the change in oxidation number of iron in this reaction?

- A. from 0 to +2
- B. from +1 to +2
- C. from 0 to -2
- D. from -1 to -2

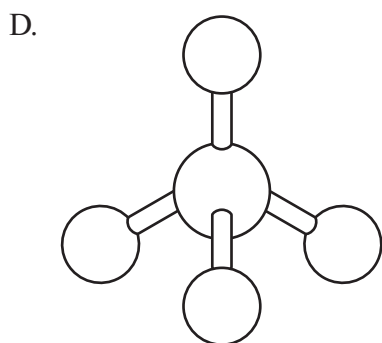
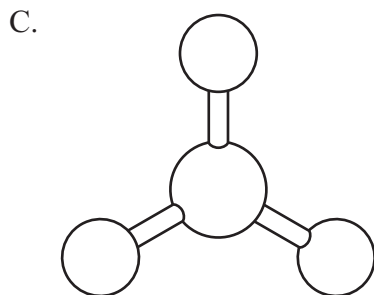
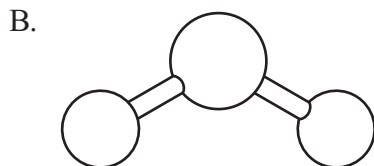
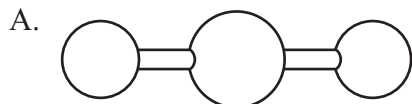
- 16 The reduction of carbon dioxide by hydrogen gas takes place at 420°C to produce water vapor and carbon monoxide. The equation for this reaction at equilibrium is shown below.



Which of the following changes in concentration occur when more water vapor is added to the system under equilibrium conditions?

- A.  $[\text{H}_2]$  decreases,  $[\text{CO}_2]$  decreases,  $[\text{CO}]$  increases
- B.  $[\text{H}_2]$  decreases,  $[\text{CO}_2]$  decreases,  $[\text{CO}]$  decreases
- C.  $[\text{H}_2]$  increases,  $[\text{CO}_2]$  increases,  $[\text{CO}]$  increases
- D.  $[\text{H}_2]$  increases,  $[\text{CO}_2]$  increases,  $[\text{CO}]$  decreases

- 17 Which of the following models **best** represents the shape of a compound with trigonal planar geometry?



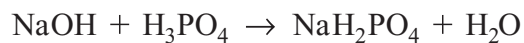
- 18 A neutral atom has an outer shell electron configuration of  $2s^2 2p^6$ . To which of the following groups of elements does it belong?

- A. alkali metals
- B. alkaline-earth metals
- C. halogens
- D. noble gases

- 19 Which of the following statements **best** explains why water has a high surface tension?
- A. The force of attraction between neighboring polar water molecules is weak.
  - B. The force of attraction between neighboring polar water molecules is strong.
  - C. The force of attraction between neighboring nonpolar water molecules is weak.
  - D. The force of attraction between neighboring nonpolar water molecules is strong.

- 20 In which of the following lists are the elements shown in order of increasing electronegativity?
- A. Li, Be, O, F
  - B. O, F, Be, Li
  - C. F, Li, O, Be
  - D. Li, F, Be, O

- 21 The balanced equation below represents the reaction of NaOH with  $\text{H}_3\text{PO}_4$ .



When 20 g of NaOH reacts with 49 g of  $\text{H}_3\text{PO}_4$ , 9 g of water is produced. How many grams of  $\text{NaH}_2\text{PO}_4$  are produced?

- A. 11 g
- B. 60 g
- C. 69 g
- D. 78 g

- 22 The average distance between molecules always increases during which of the following phase changes?

- A. gas to solid
- B. liquid to gas
- C. gas to liquid
- D. liquid to solid

Question 23 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 23 in the space provided in your Student Answer Booklet.

**23** Several properties for zinc (Zn) are listed below:

- brittle at room temperature, but malleable between 100°C and 150°C
  - bluish-white in color
  - burns in air at high temperatures, giving off zinc oxide (ZnO) gas
  - conducts heat and electricity
  - sinks in water
  - reacts with acids and bases
  - exposed surfaces tarnish in moist air
- a. Identify **two** physical properties of zinc from the list. Explain why the properties you identified are physical properties and not chemical properties.
- b. Identify **two** chemical properties of zinc from the list. Explain why the properties you identified are chemical properties and not physical properties.

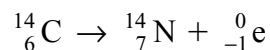
# Chemistry

## SESSION 2

### DIRECTIONS

This session contains nineteen multiple-choice questions and three open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

- 24 In radiocarbon dating, carbon-14 undergoes decay to become nitrogen-14.



What type of reaction is this?

- A. fusion
- B. neutralization
- C. nuclear
- D. oxidation

- 25 Which of the following ideas was proposed by Niels Bohr?

- A. Electrons occupy specific energy levels within an atom.
- B. The nucleus of an atom contains neutrons as well as protons.
- C. An atom is a solid sphere that cannot be separated into smaller parts.
- D. An atom consists of negative charges embedded in a positively charged sphere.

- 26 Carbon reacts with chlorine to form  $\text{CCl}_4$ . What is the name of this compound?

- A. carbon 4-chloride
- B. 1-carbon 4-chloride
- C. tetracarbon chloride
- D. carbon tetrachloride



- 27 A student has 84.0 g of  $\text{N}_2$  gas in a sealed 500 L container at  $20^\circ\text{C}$ . Which of the following equations should the student use to calculate the gas pressure?

A.  $P = 84.0 \text{ g} \times \frac{1 \text{ mol}}{28 \text{ g}} \times R \times 500 \text{ L}$

B.  $P = 84.0 \text{ g} \times \frac{28 \text{ g}}{1 \text{ mol}} \times R \times 293 \text{ K} \times 500 \text{ L}$

C.  $P = \frac{84.0 \text{ g} \times \frac{1 \text{ mol}}{28 \text{ g}} \times R \times 293 \text{ K}}{500 \text{ L}}$

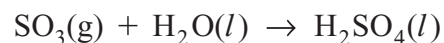
D.  $P = \frac{84.0 \text{ g} \times \frac{28 \text{ g}}{1 \text{ mol}} \times R}{500 \text{ L}}$

28 A walk-in cooler has a volume of  $1.1 \times 10^4$  L. If the temperature inside the cooler is  $3^\circ\text{C}$  and the gas pressure is 1.0 atm, how many moles of gas are inside the cooler?

- A.  $4.9 \times 10^2$  mol
- B.  $4.5 \times 10^4$  mol
- C.  $2.5 \times 10^5$  mol
- D.  $6.0 \times 10^{23}$  mol

- 29 Aluminum (Al) has three electrons in its outer shell. Oxygen (O) needs two electrons to complete its outer shell. What is the chemical formula for aluminum oxide?
- A. AlO  
B. AlO<sub>2</sub>  
C. Al<sub>2</sub>O  
D. Al<sub>2</sub>O<sub>3</sub>
- 30 Which of the following statements **best** explains why ionic solids dissolve in water?
- A. Water has high surface tension.  
B. Water is a highly polar molecule.  
C. Water is more dense as a liquid than as a solid.  
D. Water has a higher boiling point than predicted by its molar mass.

- 31 The chemical equation below represents sulfur trioxide (SO<sub>3</sub>) in the atmosphere mixing with rainwater to form sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), which is a major component of acid rain.



The molar mass of SO<sub>3</sub> is 80.1 g/mol and the molar mass of H<sub>2</sub>SO<sub>4</sub> is 98.1 g/mol. How much H<sub>2</sub>SO<sub>4</sub> is produced when 128.0 g of SO<sub>3</sub> mixes with rainwater?

- A. 98.1 g  
B. 105 g  
C. 128 g  
D. 157 g

- 32 Which of the following actions decreases the entropy of a system?
- A. boiling water  
B. freezing water  
C. dissolving salt in water  
D. mixing baking soda and salt

Question 33 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 33 in the space provided in your Student Answer Booklet.

**33** Five chemical reactions are listed in the table below.

<b>Reaction 1</b>	$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
<b>Reaction 2</b>	$\text{Ca(OH)}_2 + 2\text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$
<b>Reaction 3</b>	$\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$
<b>Reaction 4</b>	$\text{PbO}_2 \rightarrow \text{Pb} + \text{O}_2$
<b>Reaction 5</b>	$2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

- Identify **one** chemical reaction from the list that is a synthesis (combination) reaction. Explain why you identified this reaction as synthesis.
- Identify **one** chemical reaction from the list that is a decomposition reaction. Explain why you identified this reaction as decomposition.
- Describe a combustion reaction.
- Write a balanced chemical equation for a combustion reaction using some or all of the substances from the table below.

$\text{C}_3\text{H}_8$	$\text{CO}_2$
$\text{O}_2$	$\text{H}_2$
$\text{C}$	$\text{H}_2\text{O}$

Mark your answers to multiple-choice questions 34 through 43 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

- 34 Which of the following statements explains why the human body produces chemical buffers?
- A. Buffers maintain a constant pH in the blood.
  - B. Buffers dissolve salts and minerals in the blood.
  - C. Buffers decompose food molecules during digestion.
  - D. Buffers catalyze chemical reactions in the body cells.
- 35 A 6.0 M solution of HCl is diluted to 1.0 M. How many milliliters of the 6.0 M solution would be used to prepare 100.0 mL of the diluted 1.0 M solution?
- A. 6 mL
  - B. 17 mL
  - C. 33 mL
  - D. 100 mL

- 36 After crude oil is pumped out of the ground, it must be processed in a “cracking tower.” The tower separates it into less dense chemicals like butane and gasoline, and more dense chemicals like diesel fuel and tar.
- Based on this information, crude oil can best be classified as a
- A. pure compound.
  - B. mixture of compounds.
  - C. mixture of pure elements.
  - D. solution of plasma and liquid.

- 37 When a cup of hot chocolate cools from  $90^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ , which of the following is happening to the molecules of the liquid?

A. Their rate of motion is decreasing.

B. Their valence electrons are being lost.

C. Their positions are becoming fixed in crystals.

D. Their average distance from adjacent molecules is increasing.

- 38 A reaction yields 6.26 g of a product. What is the percent yield if the theoretical yield is 18.81 g?

A. 3.00%

B. 10.6%

C. 33.3%

D. 56.1%

- 39 The table below provides some information about an unidentified element.

**Physical Properties:**

- shiny silver-colored solid
- easily flattened with small hammer
- denser than water
- has 4 valence electrons

**Chemical Properties:**

- does not react with sodium
- reacts slowly with oxygen

Based on this information, the unidentified element is **best** classified as which of the following?

A. a metal in group 1 (1A)

B. a metal in group 14 (4A)

C. a nonmetal in period 4

D. a metalloid in period 5

- 40 Which of the following statements describes a gamma ray?
- A. A gamma ray has no mass.
  - B. A gamma ray has a positive charge.
  - C. A gamma ray can be stopped by a sheet of paper.
  - D. A gamma ray can be converted into a beta particle.

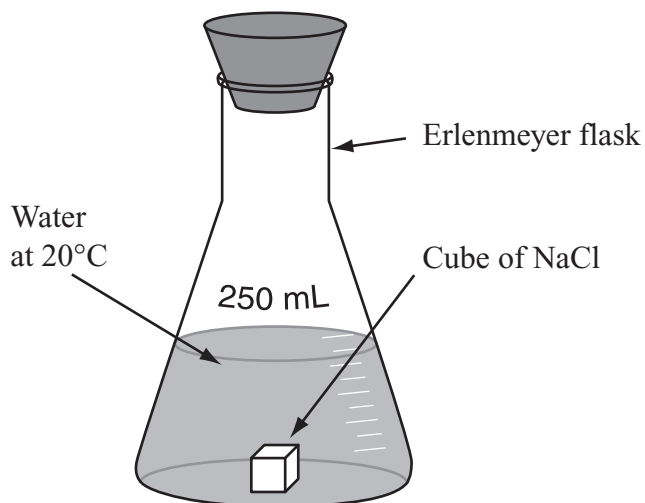
- 41 The table below shows the electronegativities of four elements.

Element	Electronegativity
carbon	2.6
fluorine	4.0
hydrogen	2.2
oxygen	3.4

Which of the following bonds is the **most** polar?

- A. carbon–hydrogen
- B. carbon–fluorine
- C. fluorine–fluorine
- D. hydrogen–oxygen

- 42 The diagram below shows a cube of sodium chloride beginning to dissolve in water.



Which of the following changes will cause the cube to dissolve more quickly?

- A. swirling the flask
- B. removing the stopper
- C. pouring off half the water
- D. decreasing the water temperature

- 43 When a scuba diver is deep underwater and exhales, air bubbles form and rise to the surface of the water. Which of the following statements **best** describes what happens to the air bubbles as they rise to the surface?

- A. The number of molecules in the bubbles increases, and the diameter of the bubbles increases.
- B. The number of molecules in the bubbles decreases, and the diameter of the bubbles decreases.
- C. The number of molecules in the bubbles remains the same, and the diameter of the bubbles increases.
- D. The number of molecules in the bubbles remains the same, and the diameter of the bubbles decreases.



Questions 44 and 45 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

**Write your answer to question 44 in the space provided in your Student Answer Booklet.**

- 44 The elements helium, neon, and xenon are located in group 18 (8A) in the periodic table.
- Explain why the atomic number increases from helium to neon to xenon.
  - Explain why helium, neon, and xenon are located in different periods in the periodic table.
  - Describe the chemical reactivity of helium, neon, and xenon **and** explain how the location of these elements in the periodic table relates to their chemical reactivity.

Write your answer to question 45 in the space provided in your Student Answer Booklet.

- 45 Glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) is formed in plants by the process of photosynthesis. The net equation for photosynthesis is shown below.



- Calculate the molar mass of glucose. Show your calculations and include units in your answer.
- Explain how the amount of carbon dioxide consumed by a plant can be determined from measuring the amount of oxygen released by the plant. Assume excess water is available.
- Calculate the amount of glucose, in grams, formed when 100 mol of  $\text{O}_2$  is released. Show your calculations and include units in your answer.

## Massachusetts Comprehensive Assessment System Chemistry Formula and Constants Sheet

### Common Polyatomic Ions

Ion	Ionic Formula
Ammonium	$\text{NH}_4^+$
Carbonate	$\text{CO}_3^{2-}$
Hydroxide	$\text{OH}^-$
Nitrate	$\text{NO}_3^-$
Phosphate	$\text{PO}_4^{3-}$
Sulfate	$\text{SO}_4^{2-}$

**Combined Gas Law:**  $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

**Ideal Gas Law:**  $PV = nRT$

**Dilution Formula:**  $M_1 V_1 = M_2 V_2$

**Molar Volume of Ideal Gas at STP:** 22.4 L/mol

**Ideal Gas Constant:**  $R = 0.0821 \text{ L} \cdot \text{atm/mol} \cdot \text{K} = 8.31 \text{ L} \cdot \text{kPa/mol} \cdot \text{K}$

**STP:** 1 atm (101.3 kPa), 273 K (0°C)

**Absolute Temperature Conversion:**  $K = ^\circ\text{C} + 273$

**Definition of pH:**  $\text{pH} = -\log [\text{H}_3\text{O}^+] = -\log [\text{H}^+]$

**Avogadro's Number:**  $6.02 \times 10^{23}$  particles/mol

### Nuclear Symbols

Name	Symbol
Alpha particle	$\alpha$ or ${}^4_2\text{He}$
Beta particle	$\beta$ or ${}^0_{-1}e$
Gamma ray	$\gamma$
Neutron	${}^1_0n$



# Massachusetts Comprehensive Assessment System

## Periodic Table of the Elements

Group (Family)

1A1

1

1.01

H

Hydrogen

2A2

2

6.94

Li

Lithium

3A3

3

9.01

Be

Beryllium

3B3

3

22.99

Na

Sodium

4B4

4

24.31

Mg

Magnesium

4B4

4

44.96

Sc

Scandium

5B5

5

47.88

Ti

Titanium

6B6

6

50.94

V

Vanadium

7B7

7

52.00

Cr

Chromium

8B8

8

54.94

Mn

Manganese

9B9

9

55.85

Fe

Iron

10B10

10

58.93

Co

Cobalt

11B11

11

58.69

Ni

Nickel

12B12

12

63.55

Cu

Copper

13B13

13

65.39

Zn

Zinc

14B14

14

69.72

Ga

Gallium

15B15

15

72.59

Ge

Germanium

16B16

16

74.92

As

Arsenic

17B17

17

75.90

Se

Selenium

18B18

18

79.90

Br

Bromine

19B19

19

83.80

Kr

Krypton

20B20

20

86.91

Rb

Rubidium

21B21

21

87.62

Sr

Strontium

22B22

22

88.91

Y

Yttrium

23B23

23

89.90

Zr

Zirconium

24B24

24

91.22

Nb

Niobium

25B25

25

92.91

Mo

Molybdenum

26B26

26

95.94

Tc

Technetium

27B27

27

98.91

Ru

Ruthenium

28B28

28

101.07

Rh

Rhodium

29B29

29

102.91

Pd

Palladium

30B30

30

106.42

Ag

Silver

31B31

31

107.87

Cd

Cadmium

32B32

32

112.41

In

Indium

33B33

33

114.82

Sn

Tin

34B34

34

118.71

Sb

Antimony

35B35

35

121.75

Te

Tellurium

36B36

36

126.91

I

Iodine

37B37

37

131.29

Xe

Xenon

38B38

38

132.91

Cs

Cesium

39B39

39

137.33

Ba

Barium

40B40

40

140.12

La

Lanthanum

41B41

41

140.91

Ce

Cerium

42B42

42

144.24

Pr

Praseodymium

43B43

43

147.07

Nd

Neodymium

44B44

44

150.36

Pm

Promethium

45B45

45

151.96

Sm

Samarium

46B46

46

157.25

Eu

Europium

47B47

47

158.93

Gd

Gadolinium

48B48

48

162.50

Tb

Terbium

49B49

49

164.93

Dy

Dysprosium

50B50

50

167.26

Ho

Holmium

51B51

51

168.93

Er

Erbium

52B52

52

173.04

Tm

Thulium

53B53

53

174.97

Yb

Ytterbium

54B54

54

175.94

Lu

Lutetium

55B55

55

188.91

Ac

Actinium

56B56

56

189.04

Th

Thorium

57B57

57

190.02

Pa

Protactinium

58B58

58

192.22

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Uranium

59B59

59

194.04

Np

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60B60

60

196.08

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Plutonium

61B61

61

201.07

Am

Americium

62B62

62

207.97

Cm

Curium

63B63

63

208.98

Bk

Berkelium

64B64

64

210.08

Cf

Californium

65B65

65

210.98

Es

Einsteinium

66B66

66

210.98

Fm

Fermium

67B67

67

215.02

Md

Mendelevium

68B68

68

216.00

No

Nobelium

69B69

69

217.00

Lr

Lawrencium

1A1

1

1.01

H

Hydrogen

2A2

2

6.94

Li

Lithium

3A3

3

9.01

Be

Beryllium

3B3

3

22.99

Na

Sodium

4B4

4

24.31

Mg

Magnesium

4B4

4

44.96

Sc

Scandium

5B5

5

47.88

Ti

Titanium

6B6

6

50.94

V

Vanadium

7B7

7

52.00

Cr

Chromium

8B8

8

54.94

Mn

Manganese

9B9

9

55.85

Fe

Iron

10B10

10

58.93

Co

Cobalt

11B11

11

58.69

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Terbium

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Dysprosium

50B50

50

167.26

Ho

Holmium

51B51

51

168.93

Er

Erbium

52B52

52

173.04

Tm

Thulium

53B53

53

174.97

Yb

Ytterbium

54B54

54

175.94

Lu

Lutetium

55B55

55

188.91

Ac

Actinium

56B56

56

189.04

Th

Thorium

57B57

57

190.02

Pa

Protactinium

58B58

58

192.22

U

Uranium

59B59

59

194.04

Np

Neptunium

60B60

60

196.08

Pu

Plutonium

61B61

61

201.07

Am

Americium

62B62

62

207.97

Cm

Curium

63B63

63

208.98

Bk

Berkelium

64B64

64

210.08

Cf

Californium

65B65

65

210.98

Es

Einsteinium

66B66

66

210.98

Fm

Fermium

67B67

67

215.02

Md

Mendelevium

68B68

68

216.00

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Nobelium

69B69

69

217.00

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1A1

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Na

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4B4

4

24.31

Mg

Magnesium

4B4

4

44.96

Sc

Scandium

5B5

5

47.88

Ti

Titanium

6B6

6

50.94

V

Vanadium

7B7

7

52.00

Cr

Chromium

8B8

8

54.94

Mn

Manganese

9B9

9

55.85

Fe

Iron

10B10

10

58.93

Co

Cobalt

11B11

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58.69

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Nickel

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Terbium

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51

168.93

Er

Erbium

52B52

52

173.04

Tm

Thulium

53B53

53

174.97

Yb

Ytterbium

54B54

54

175.94

Lu

Lutetium

55B55

55

188.91

Ac

Actinium

56B56

56

189.04

Th

Thorium

57B57

57

190.02

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Protactinium

58B58

58

192.22

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Uranium

59B59

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194.04

Np

Neptunium

60B60

60

196.08

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61B61

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Curium

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Berkelium

64B64

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Californium

65B65

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210.98

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Einsteinium

66B66

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210.98

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Mendelevium

68B68

68

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No

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69B69

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9B9

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Nickel

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Copper

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65.39

Zn

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Strontium

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Yttrium

23B23

23

89.90

Zr

Zirconium

24B24

24

91.22

Nb

Niobium

25B25

25

92.91

Mo

Molybdenum

26B26

26

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Tc

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27B27

27

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31B31

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Cadmium

32B32

32

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33

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34

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35B35

35

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Tellurium

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36

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37B37

37

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Xenon

38B38

38

132.91

Cs

Cesium

39B39

39

137.33

Ba

Barium

40B40

40

140.12

La

Lanthanum

41B41

41

140.91

Ce

Cerium

42B42

42

144.24

Pr

Praseodymium

43B43

43

147.07

Nd

Neodymium

44B44

44

150.36

Pm

Promethium

45B45

45

151.96

Sm

Samarium

46B46

46

157.25

Eu

Europium

47B47

47

158.93

Gd

Gadolinium

48B48

48

162.50

Tb

Terbium

49B49

49

164.93

Dy

Dysprosium

50B50

50

167.26

Ho

Holmium

51B51

51

168.93

Er

Erbium

52B52

52

173.04

Tm

Thulium

53B53

53

174.97

Yb

Ytterbium

54B54

54

175.94

Lu

Lutetium

55B55

55

188.91

Ac

Actinium

56B56

56

189.04

Th

Thorium

57B57

57

190.02

Pa

Protactinium

58B58

58

192.22

U

Uranium

59B59

59

194.04

Np

Neptunium

60B60

60

196.08

Pu

Plutonium

61B61

61

201.07

Am

Americium

62B62

62

207.97

Cm

Curium

63B63

63

208.98

Bk

Berkelium

64B64

64

210.08

Cf

Californium

65

Key:

atomic weight
Symbol
atomic number
Name

Mass numbers in parentheses are those of the most stable or most common isotope.

Lanthanide Series

Actinide Series

\*Revised based on IUPAC Commission on Atomic Weights and Isotopic Abundances, "Atomic Weights of the Elements 2007."

**High School Chemistry**  
**Spring 2012 Released Items:**  
**Reporting Categories, Standards, and Correct Answers\***

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
1	331	Properties of Matter and Thermochemistry	6.4	A
2	331	Atomic Structure and Periodicity	2.2	A
3	332	Solutions, Equilibrium and Acid Base Theory	7.4	D
4	333	Bonding and Reactions	5.1	C
5	333	Atomic Structure and Periodicity	2.2	C
6	334	Properties of Matter and Thermochemistry	1.1	A
7	335	Properties of Matter and Thermochemistry	6.1	D
8	335	Atomic Structure and Periodicity	2.4	B
9	335	Solutions, Equilibrium and Acid Base Theory	7.5	D
10	335	Solutions, Equilibrium and Acid Base Theory	8.1	B
11	336	Solutions, Equilibrium and Acid Base Theory	8.2	
12	337	Properties of Matter and Thermochemistry	6.3	B
13	337	Bonding and Reactions	4.2	A
14	338	Atomic Structure and Periodicity	2.7	A
15	338	Bonding and Reactions	8.4	A
16	339	Solutions, Equilibrium and Acid Base Theory	7.6	D
17	340	Bonding and Reactions	4.4	C
18	340	Atomic Structure and Periodicity	3.3	D
19	341	Bonding and Reactions	4.5	B
20	341	Atomic Structure and Periodicity	3.4	A
21	342	Atomic Structure and Periodicity	2.3	B
22	342	Properties of Matter and Thermochemistry	1.3	B
23	343	Properties of Matter and Thermochemistry	1.1	
24	344	Atomic Structure and Periodicity	2.6	C
25	344	Atomic Structure and Periodicity	2.1	A
26	344	Bonding and Reactions	4.6	D
27	345	Properties of Matter and Thermochemistry	6.2	C
28	346	Properties of Matter and Thermochemistry	6.2	A
29	347	Bonding and Reactions	4.1	D
30	347	Solutions, Equilibrium and Acid Base Theory	7.1	B
31	347	Bonding and Reactions	5.5	D
32	347	Properties of Matter and Thermochemistry	6.5	B
33	348	Bonding and Reactions	5.2	
34	349	Solutions, Equilibrium and Acid Base Theory	8.3	A
35	349	Solutions, Equilibrium and Acid Base Theory	7.2	B
36	349	Properties of Matter and Thermochemistry	1.2	B
37	350	Properties of Matter and Thermochemistry	6.3	A
38	350	Bonding and Reactions	5.6	C
39	350	Atomic Structure and Periodicity	3.2	B
40	351	Atomic Structure and Periodicity	2.5	A

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
41	351	<i>Bonding and Reactions</i>	4.3	B
42	352	<i>Solutions, Equilibrium and Acid Base Theory</i>	7.3	A
43	352	<i>Properties of Matter and Thermochemistry</i>	6.1	C
44	353	<i>Atomic Structure and Periodicity</i>	3.1	
45	354	<i>Bonding and Reactions</i>	5.3	

\* Answers are provided here for multiple-choice items only. Sample responses and scoring guidelines for open-response items, which are indicated by shaded cells, will be posted to the Department's website later this year.